Space Weather Technical Forecast

Issued on Sunday, 02 January 2022 at 01:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance of G1/Minor storm on 02 January. Slight chance of moderate solar activity throughout.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity was moderate, with one M1.1 flare from AR2918, at 01/0733UTC. There was also one C8.1 flare from AR2918 at 01/1909UTC. Neither of these flares appear to have produced a CME. There are four sunspots on the disc in total. AR2918 (Bxo/Beta) which is the most active, as fluctuated between a bi-polar region and fading to plage, but still contains a significant level of magnetic flux. AR2916 (Eai/Beta) is the largest region, but has been relatively inactive, with small changes in the appearance of the trailer spots and low level B-class flaring. A filament eruption emanated from this region around 01/1343UTC, but no CME was discernible on coronograph imagery. The remaining two sunspot regions appear to be stable, with no significant activity.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, have followed a stepped increase through the last 24 hours, as the Earth connected with the high speed stream from coronal hole 40. The first increase was from 400km/s to around 475km/s at 01/0146UTC, followed by an increase to average of 550km/s at 01/0856UTC. A further increase to 600km/s was observed at the end of the period. Density started around average, but increased above average at 01/0856UTC, reaching a peak of 12ppcc. Total magnetic field strength started moderate, with a peak of 10nT at 01/0146UTC, but has gradually weakened through the period. The north-south component, Bz varied moderately at first, with a negative peak of -8nT at 01/0238UTC, but has since been weak. Phi angle has been positive (away from the Sun) throughout. Geomagnetic activity has been mainly Quiet to Unsettled (Kp 1-3) with an Active (Kp4) interval between 01/0300-0600UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at background levels. High energy electron flux (greater than 2MeV) has been background or moderate levels. Electron fluence was well below the Active threshold at 3.99e6 integrated pfu at 01/2400UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Mainly low solar activity is forecast, with a slight chance of moderate solar activity, due mainly to regions AR2916 and AR2918.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are forecast. A high speed stream from coronal hole 40 is expected to continue to average around 500-600km/s through 02 January, but then decline during 03 and 04 January to background levels. Geomagnetic activity is expected to be mainly Unsettled through 02 and 03 January, with a chance of Active intervals and a slight chance of G1/Minor storms. Mainly Quiet to Unsettled conditions are then expected through 04 and 05 January as the high speed stream declines.

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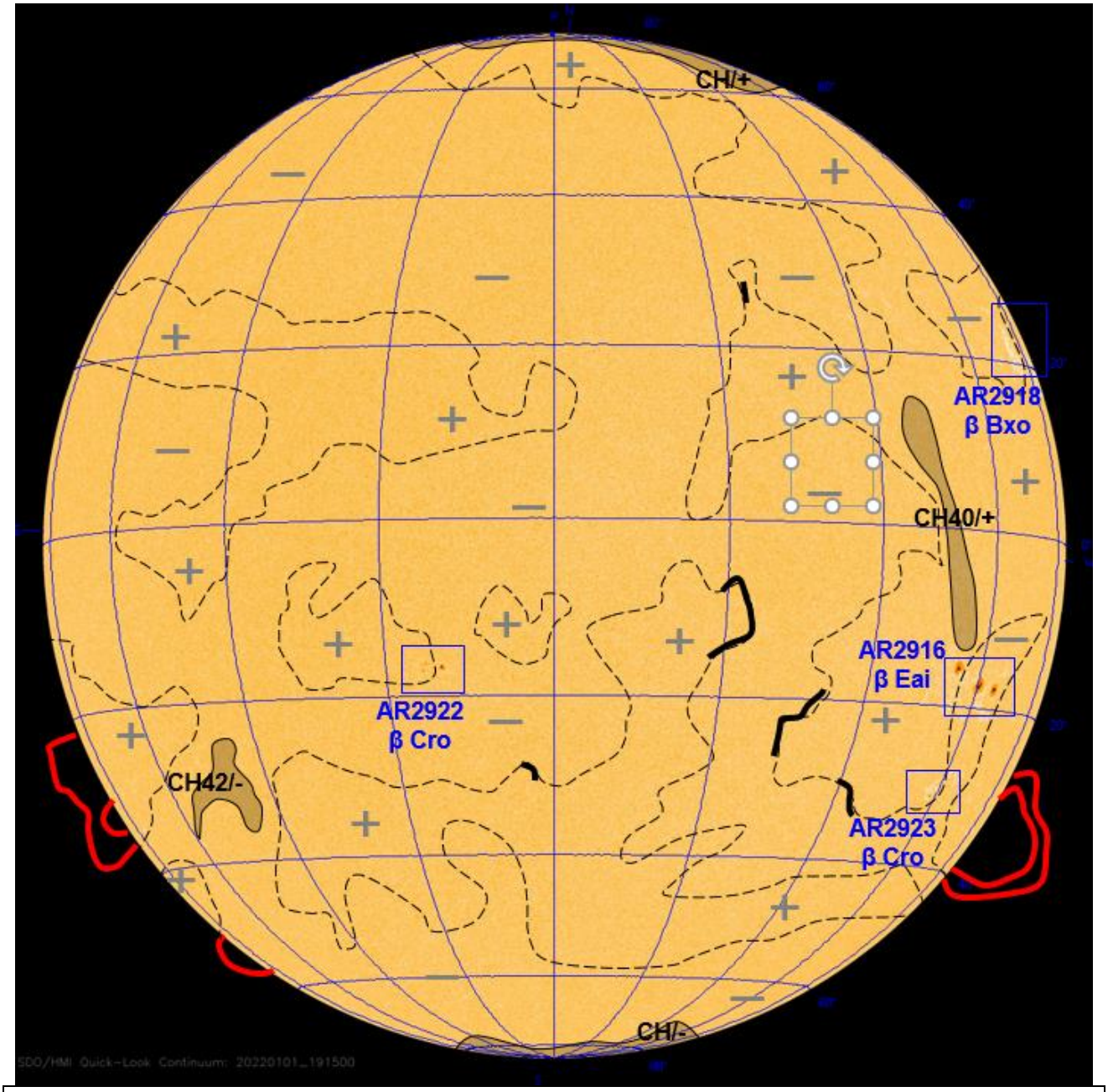
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, albeit with a very slight chance of S1 due to the potential contained within the two most significant sunspot regions. High energy electron flux is expected to be at background to moderate levels through 02 and 03 January, with an increasing chance of exceeding the high (1e3pfu) threshold on 04 and 05 January. Electron fluence is forecast to remain well below the Active (1e8 integrated pfu) threshold, but with an increasing trend later in the period.

Figure 1. Solar Analysis Valid 01/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs are forecast, with no CME evident following the M1.1 flare early on 01 January.

The high speeds stream from coronal hole 40 is expected to average around 500-600km/s through 02 January, with a decline then forecast during 03 and 04 January.

Geomagnetic activity is expected to be mainly Unsettled through 02 and 03 January, with a chance of Active intervals in any sustained periods of negative Bz, along with a slight chance of G1/Minor storms. Mainly Quiet to Unsettled conditions are then expected through 04 and 05 January as the high speed stream declines.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

None expected

Figure 2: L1 solar wind parameters, observed by DSCOVR

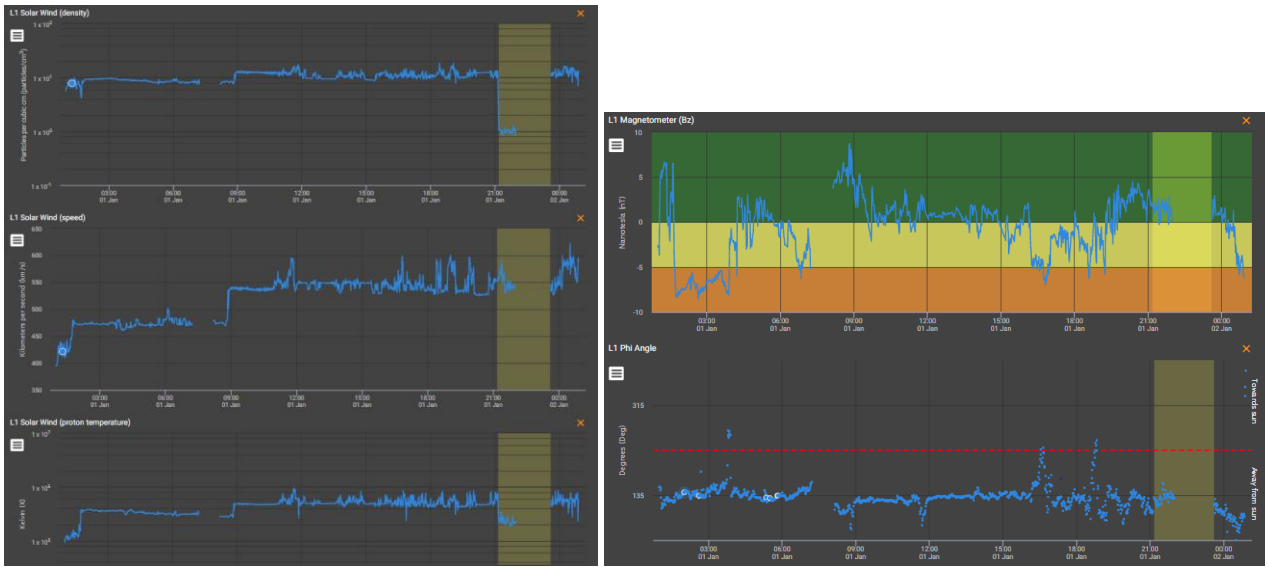

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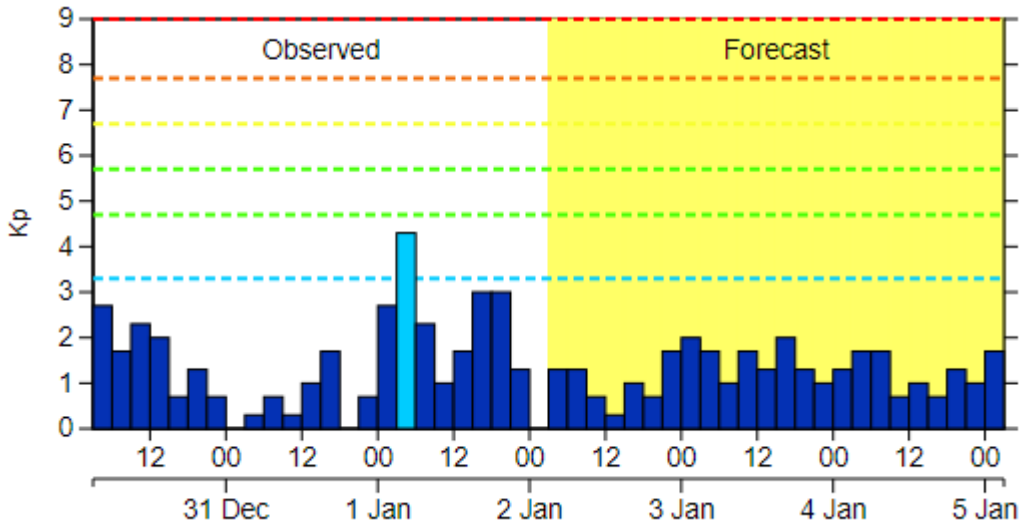
Figure 3: Observed and forecast geomagnetic activity from British geological survey



Radio Blackouts - X-Ray Flares:

Solar activity is expected to be moderate or low through the next four days.

AR2918 (Bxo/Beta) has been the most active region over the last 48 hours, with a large amount of magnetic flux contained in the region despite the rather simple visible and magnetic appearance. This region is will rotate across the western horizon on 02 January, with the risk then concentrated in mature region AR2916 (Eai/Beta), which despite being large and carrying a large flare risk, has shown very little recent activity. An evolution of the trailer spots through the last 24 hours, suggests that there is still a risk of further activity. This region will be on the visible disc through the next three days, with a small risk of M-class flares through the period.
The two remaining sunspots on the disc are currently benign and stable.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	20	10	10	5
Very Active	R3 to R5 X Class	No	3	1	1	1

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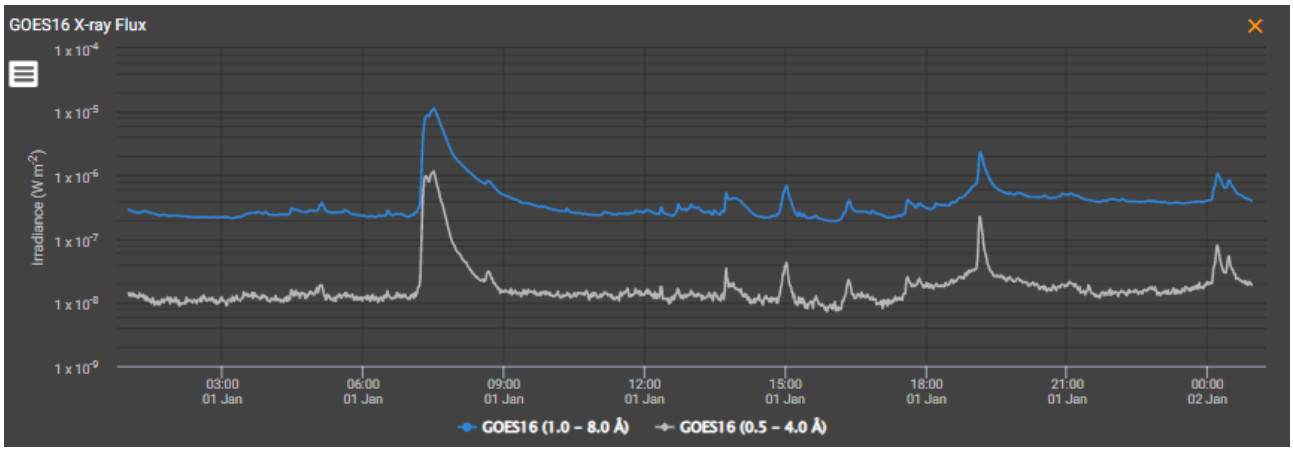
Figure 4: GOES 16 X-ray flux



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at background levels and will most likely persist as such. Despite the apparent stability, 2916 and 2918 continue to be monitored for potential radiation storms.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) is expected to remain at moderate or background levels through 02 January due to the geomagnetic enhancements caused by the high speed stream. Given that the high speed stream is strong, the radiation belts are likely to be distorted, so the GOES spacecraft may not be sampling the greatest concentration of electrons on 02 and 03 January. As the solar wind eases through 04 and 05 January, the electron flux is likely to increase as the radiation belts relax into the standard position, with an increasing risk of reaching the high (1e3pfu) threshold.

Electron fluence is expected to remain below the Active threshold, but with a rising trend through 04 and 05 January as the electron flux increases.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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